

CLUTCH SIZE, INCUBATION AND HATCHING SUCCESS OF GHARIAL [*GAVIALIS GANGETICUS* (GMELIN)] EGGS FROM NARAYANI RIVER, NEPAL, 1976-1978¹

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INTRODUCTION

Gharial eggs were collected from 1976, in Narayani river, Nepal, for captive incubation as part of a conservation programme on the endangered gharial. In 1976 the eggs were collected by myself, in 1977 by myself in association with HMG Nepal's Special Officer (Gharial), and in 1978 by HMG Nepal gharial staff only.

The only published data for clutch size of the gharial is that of Malcolm Smith (1931) who stated,

"Their eggs, 40 or more in number, are deposited in sandbanks"

and Parshad (1914), who removed 56 eggs from the oviducts of a 9 foot 7 inch female which he shot at Ferozapore.

The data presented below as well as providing hitherto unknown information on aspects of the nesting biology of the gharial allow comparison of clutch size, incubation and hatching success between years.

MATERIALS AND METHODS

Nesting took place on high riverine sandbanks which were protected by project staff, hence the date of egg laying was known pre-

cisely (Bustard, in prepn. a). In 1976 eggs were transported to Orissa for incubation. In 1977, in part because of the poor incubation results achieved in 1976, and also as part of a Nepalese training programme, all nests were incubated in Nepal. This was carried out by reburying the eggs as whole nests as collected in a mid-river sandbank at Korea Mohan which was enclosed by a predator-proof wood and wire-mesh enclosure with access through a hatch in the roof.

Due to unseasonable weather in 1977—pre-monsoon showers started at the time of egg-laying in early April and continued until the onset of the monsoon—this sandbank flooded well before hatching. Anticipating this the nests were all removed several weeks prior to hatching and completed their incubation in sand in metal trunks in a specially-heated room at Tiger Tops Jungle Lodge, Royal Chitwan National Park. As far as possible this room was maintained between 30-32°C but temperatures sometimes fell below this range. In 1978 eggs were incubated in the same island hatchery but again had to be moved due to early floods, this time to the Park headquarters at Kasara, where the hatchery room was maintained between 30-35°C with aid of heaters.

RESULTS

The data recorded during the three years are given in Tables 1-4. The various topics

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are taken up separately below:

Clutch Size:

Clutch size in 1976 varied from 18 to 40 eggs (mean 28.6, Table 1). In 1977 the range was 16-61 (mean 36.9) eggs (Table 2) and in 1978 18-45 (mean 31) eggs (Tables 3 and 4).

The differences in mean clutch size between 1976 and 1977 should be noted (28.6 and 36.9 eggs) respectively—a mean increase/clutch of 8.3 eggs in 1977 as compared to 1976. In 1978 mean clutch size at 31 eggs was intermediate between the two previous years.

Nesting Season:

The nesting season is usually very discrete, at least in any one area. It proceeded up river towards the hill country (Bustard, in prep. b). In 1976 all the nests collected on the Narayani river between Royal Chitwan National Park and the Indian border were laid between 29 March and 8 April (Table 1). However, one nest on the Narayani upstream of the National Park was not laid until 19 April and two nests on the small stretch of the Kali-Gandaki were laid nine days apart (12 and 21 April).

The data for 1977 show very discrete nesting by nesting area (Table 2). In 1978 nesting is again all very discrete, all occurring within six days (2-7 April) for eight nests for which date of laying is known (Table 3).

Fertility:

In many nests (see Tables 1 and 2) a sizable proportion of the eggs would appear to be infertile at least according to the criteria for fertility given above.

The mean percentage fertility in 1976 was 50.4 (data provided by Mr. L. A. K. Singh). In 1977 I recorded a mean percentage fertility of 82.5 which would appear more normal. Comparable data were apparently not record-

ed in 1978.

Percentage Hatch:

The percentage hatch also varied greatly (Table 1-4) from a low of 24.2% (1976) to a high of 75.1% (1977). The overall figure for 1978 was 52.5% but this is increased to 65.3% if the results of the three nests left for natural incubation are not included.

Incubation Period:

The mean for the incubation period for the three years (excluding those three nests left in nature in 1978) were 84, 94 and 83 days for the years 1976, 1977 and 1978 respectively (Tables 1-3). The considerable variations within any one year should be noted, the incubation spread being 16, 15 and 8 days in each of the three years respectively.

DISCUSSION

Inter-year variations in clutch size:

Major interest centres around the large mean differences in clutch size between years. It is known that in many species of reptiles, larger (older) females lay more eggs (Bustard 1972), although this is not necessarily the case, as some species would appear to be exceptions (Bustard, *ibid.*). However, at least in those species laying larger egg clutches inter-year differences in clutch size or total egg production, may be more important than any effect of larger clutches from larger females, as shown by Bustard (*ibid.*) on the basis of very extensive data for the green sea turtle (*C. mydas*), a species in which clutch size is positively correlated with female size.

Bustard postulated that these inter-year differences in egg production by *C. mydas*, may reflect differing feeding opportunities in the inter-nesting years spent at sea. In the case of the gharial, data were recorded on a small number of breeding females which presumably bred annually. The 1976 data (on nine nests)

shows a mean clutch size of 25.5 eggs whereas the 1977 data (on 16 nests) shows a mean clutch size of 36.9 eggs—a mean increase/clutch of 11.4 eggs. No obvious explanation is available to explain these differences. In 1978 the data on 10 nests gave an intermediate figure of 31.0 eggs. These differences cannot be explained on the basis of sampling biases as an attempt was made to collect every nest each year.

An examination of the distribution of clutch size variations in the various years indicates that in all three years there were no clutches of under 10 eggs (the smallest clutches in the three years were 16, 16 and 18 eggs respectively). The largest clutch sizes were 39, 61 and 45 eggs respectively. However, the mean of 36.9 eggs in 1977 reflects a marked shift towards larger clutch sizes in *all* nests. Twelve (of 16) nests fell in the 31-40 clutch size group in 1977 and three occurred in larger groups as opposed to three (of 9) in this group in 1976 which represented the largest clutch size grouping in 1976.

Discrete nesting season:

The discrete nesting season of this population of the gharial has been commented upon elsewhere for the 1977 nesting season (Bustard, in prepn. b). The data presented here indicates that a very discrete nesting season characterised all three years.

Fertility:

A percentage of apparently infertile eggs are a feature of most reptiles which deposit large clutches of eggs. However, the percentage fertility figure for 1976 (of 50.4%) should be treated with caution as it appears abnormally low. It seems likely that some early embryonic deaths may have remained undetected at subsequent examination. The 82.5% figure for 1977 is considered more normal. Examination

of the intra-nest data (Table 2) indicates that fertility varies from a high of 100% (two nests) to a low of 22.8% but with the exception of this single nest and one of 59% the lowest per cent fertility recorded was 73%.

Percentage Hatch:

The percentage hatch figures are clearly closely related to the level of fertility. Examination of the detailed data for 1977 shows that most fertile eggs result in hatchlings. The differences between fertility and percentage hatch figures are accounted for by embryonic deaths—which except for exceptional circumstances such as flooding—are usually relatively few.

Hatching results were extremely poor in 1976. Reasons for this are not known. The distance over which the eggs were transported, 1400 km. was not a key factor, gharial eggs often being transported over very long distances in the Project either freshly laid or two-thirds incubated and subsequently achieve very high levels of successful hatch (Bustard in prepn. a; and S. Choudhury, unpubl.). The 1977 hatching figures (75%), on the other hand are surprisingly good, as nest temperatures were extremely low (near 28.3C) due to the persistent wet weather throughout the incubation period (Bustard, in prepn. b). Furthermore, these eggs were dug up twice during incubation, once when freshly laid, and again towards the end of the incubation period, to complete their incubation in a heated room where, in the absence of electricity, temperatures were frequently less than ideal. The 1978 hatch (65%) was likewise achieved by HMG Nepal staff despite having to move the eggs twice at similar times to 1977.

Natural nest failures:

The reason for the very poor incubation success of at least two of three nest left in

GHARIAL FROM NARAYANI RIVER

TABLE 1

DATE OF EGG LAYING, NESTING SITE, CLUTCH SIZE, HATCHING SUCCESS AND INCUBATION PERIOD (DAYS) IN 1976.

Nest No.	Date of Laying	Location	Clutch Size	Number Fertile	Percentage Fertile	Number Hatched	Percentage Hatched	Incubation Period
1.	29/3	Narayani River	27	19	70.4	4	14.8	85
2+3*	3/4	Narayani River	41	33	80.5	13	31.7	85-6
4.	5/4	Narayani River	18	17	94.4	3	16.7	83
5.	8/4	Narayani River	39	20	51.3	17	43.6	76
6.	8/4	Kali-Gandaki	32	29	90.6	23	71.9	92
7.	12/4	Kali-Gandaki	24	0	0	0	0	—
8.	19/4	Narayani River	33	22	66.7	5	15.2	84-5
9.	21/4	Kali-Gandaki	16	0	0	0	0	—
Mean	—	—	25.5	—	50.4	—	24.2	84

* These nests were collected by local people and the eggs mixed prior to their reaching project staff.

TABLE 2

DATE OF EGG LAYING, NESTING SITE, CLUTCH SIZE, HATCHING SUCCESS AND INCUBATION PERIOD (DAYS) IN 1977.

Nest No.	Date of Laying	Clutch Size	Number Fertile	Percentage Fertile	Number Hatched	Percentage Hatched	Incubation Period
1.	4/4	39	23	59.0	22	56.4	95
2.	4/4	16	12	75.0	8	50.0	94-6
3.	1/4	47*	36	78.2	25	54.3	98-102
4.	6/4	38*	27	73.0	25	67.5	93-95
5	2/4	33*	32	100.0	32	100.0	99
6	1/4	32	32	100.0	28	90.6	95
7.	3/4	61	53	90.6	50	82.9	95-7
8.	31/3	31	29	93.5	29	93.5	99-101
9.	31/3	50***	36	76.6	36	76.6	101-2
10.	3/4	34	32	94.1	28	82.3	96
11.	8/4	37*	33	91.7	33	89.1	91-2
12.	14/4	35	8	22.8	8	22.8	89
13.	14/4	37*	33	91.7	33	91.6	88-89
14.	8/4	31	27	87.1	22	70.9	90-91
15.	9/4	37**	35	100.0	34	97.1	87-8
16.	10/4	33*	28	87.5	25	75.7	89-90
Mean	—	36.9	—	82.5	+	75.1	94

Note: Due to damage at the time of laying the number incubated may vary slightly from the number laid. Clutches marked (*) indicate that 1 egg less, (**) 2 eggs less and (***) 3 eggs less than the clutch size was incubated.

TABLE 3

DATE OF EGG LAYING, NESTING SITE, CLUTCH SIZE, HATCHING SUCCESS AND INCUBATION PERIOD (DAYS) IN 1978. ALL PLACES NAMED REFER TO NARAYANI RIVER.

Nest No	Date of Laying	Location	Clutch Size	Number Hatched	Percentage Hatched	Incubation Period
1.	3/4	Tamaspur	45	40	88.8	84
2.	3/4	Badarjhola	44	18	40.9	85-7
3.	4/4	Badarjhola	42	40	95.2	83-4
4.	5/4	Tamaspur	25	17	73.9	83
5.	6/4	Tamaspur	18	2	11.1	89
6.	6/4	Tamaspur	29	25	86.2	81
7.	7/4	Tamaspur	24	5	20.8	83
Mean	—	—	32.4	—	65.3	83

TABLE 4

DATE OF EGG LAYING, NESTING SITE, CLUTCH SIZE, HATCHING SUCCESS AND INCUBATION PERIOD (DAYS) FOR THREE NESTS LEFT FOR NATURAL INCUBATION IN 1978

Nest No	Date of Laying	Location	Clutch Size	Number Hatched	Percentage Hatched	Incubation Period
1.	Not recorded	Badarjhola	23	10	56.5	Not known
2.	Not recorded	Badarjhola	27*	0	0	Not known
3.	2-4-1978	Deoghat	33	2	6.0	105
Mean	—	—	27.7	—	31.8	—

* Eggs markedly smaller than normal.

nature in 1978 is not known.

The clutch of markedly smaller eggs may well have been defective. The HMG Nepal report (Maskey and Ram Pritt 1978) does not provide information on this point. It would seem, however, that early onset of the monsoon resulted in water logging of the nests, resulting in total loss of two nests and loss of most of the eggs in the third nest the only eggs hatching being the uppermost which were not flooded. A similar situation has been observed in the Saltwater Crocodile (*Crocodylus porosus*) by Webb *et al.* (1977) and by Kar and Bustard (in prepn.). In the absence of

concrete data this is purely hypothesis, however, Bustard (in prepn. b), on the basis of his data, stated that in 1977 most natural nests in Narayani would have failed to hatch because of water logging following early onset of the monsoon. It appears that this was again the situation in 1978.

Incubation period:

The means for 1976 and 1978 vary by only one day (83 and 84 days respectively). The ten-eleven day longer incubation period in 1977 is explicable on the basis of the very low temperatures existing in the natural sand-

banks in that year, commented on by Bustard (in prepn., b), as a result of pre-monsoon showers commencing in early April at the time of egg laying, and persisting until the onset of the monsoon proper in June. Since egg incubation is temperature-related, the persistent rains, which cool down the nesting sandbanks, result in a lengthened incubation period.

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